



CLAIMS LISTING

- 1 1. (currently amended) A method for optimizing a wireless electromagnetic
2 communications network, comprising:
3 a wireless electromagnetic communications network, comprising
4 a set of nodes, said set of nodes further comprising,
5 at least a first subset wherein each node is MIMO-capable,
6 comprising:
7 an antennae array of $M [M]$ antennae, where $M [M] \geq$ one,
8 a transceiver for each antenna in said spatially diverse
9 antennae array,
10 means for digital signal processing to convert analog radio
11 signals into digital signals and digital signals into analog
12 radio signals,
13 means for coding and decoding data, symbols, and control
14 information into and from digital signals,
15 diversity capability means for transmission and reception of
16 said analog radio waves[signals],
17 and,
18 means for input and output from and to a non-radio
19 interface for digital signals;
20 said set of nodes being deployed according to design rules that prefer
21 meeting the following criteria:
22 said set of nodes further comprising two or more proper subsets of
23 nodes, with a first proper subset being the transmit uplink / receive
24 downlink set, and a second proper subset being the transmit
25 downlink / receive uplink set;
26 each node in said set of nodes belonging to no more transmitting
27 uplink or receiving uplink subsets than it has diversity capability
28 means;

31 each node in a transmit uplink / receive downlink subset has no
32 more nodes with which it will hold time and frequency coincident
33 communications in its field of view, than it has diversity capability
34 [means];
35 each node in a transmit downlink / receive uplink subset has no
36 more nodes with which it will hold time and frequency coincident
37 communications in its field of view, than it has diversity capability
38 [means];
39 each member of a transmit uplink / receive downlink subset cannot
40 hold time and frequency coincident communications with any
41 other member of that transmit uplink / receive downlink subset;
42 and,
43 each member of a transmit downlink / receive uplink subset cannot
44 hold time and frequency coincident communications with any
45 other member of that transmit downlink / receive uplink subset;
46 transmitting, in said wireless electromagnetic communications network,
47 independent information from each node belonging to a first proper subset, to one
48 or more receiving nodes belonging to a second proper subset that are viewable
49 from the transmitting node;
50 processing independently, in said wireless electromagnetic communications
51 network, at each receiving node belonging to said second proper subset,
52 information transmitted from one or more nodes belonging to said first proper
53 subset;
54 and,
55 dynamically adapting the diversity ~~channels~~[capability means] and said proper
56 subsets to optimize said network.

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59 2. (currently amended) A method for optimizing a wireless electromagnetic
60 communications network, comprising:
61 a wireless electromagnetic communications network, comprising

62 a set of nodes, said set of nodes further comprising,
63 at least a first subset wherein each node is MIMO-capable,
64 comprising:
65 a spatially diverse antennae array of M [M] antennae,
66 where M [M] \geq two,
67 a transceiver for each antenna in said spatially diverse
68 antennae array,
69 means for digital signal processing to convert analog radio
70 signals into digital signals and digital signals into analog
71 radio signals,
72 means for coding and decoding data, symbols, and control
73 information into and from digital signals,
74 diversity capability means for transmission and reception of
75 said analog radio waves[signals],
76 and,
77 means for input and output from and to a non-radio
78 interface for digital signals;
79 said set of nodes being deployed according to design rules that prefer
80 meeting the following criteria:
81 said set of nodes further comprising two or more proper subsets of
82 nodes, with a first proper subset being the transmit uplink / receive
83 downlink set, and a second proper subset being the transmit
84 downlink / receive uplink set;
85 each node in said set of nodes belonging to no more transmitting
86 uplink or receiving uplink subsets than it has diversity capability
87 means;
88 each node in a transmit uplink / receive downlink subset has no
89 more nodes with which it will hold time and frequency coincident
90 communications in its field of view, than it has diversity capability
91 [means];

92 each node in a transmit downlink / receive uplink subset has no
93 more nodes with which it will hold time and frequency coincident
94 communications in its field of view, than it has diversity capability
95 [means];
96 each member of a transmit uplink / receive downlink subset cannot
97 hold time and frequency coincident communications with any
98 other member of that transmit uplink / receive downlink subset;
99 and,
100 each member of a transmit downlink / receive uplink subset cannot
101 hold time and frequency coincident communications with any
102 other member of that transmit downlink / receive uplink subset;
103 transmitting, in said wireless electromagnetic communications network,
104 independent information from each node belonging to a first proper subset, to one
105 or more receiving nodes belonging to a second proper subset that are viewable
106 from the transmitting node;
107 processing independently, in said wireless electromagnetic communications
108 network, at each receiving node belonging to said second proper subset,
109 information transmitted from one or more nodes belonging to said first proper
110 subset;
111 and,
112 dynamically adapting the diversity **channels** [capability means] and said proper
113 subsets to optimize said network.
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116 3. (currently amended) A method as in claim 1, wherein dynamically adapting the
117 diversity **channels** [capability means] and said proper subsets to optimize said network
118 further comprises:
119 using substantive null steering to minimize SINR between nodes transmitting and
120 receiving information.
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- 123 4. (currently amended) A method as in claim 1, wherein dynamically adapting the
124 diversity ~~channels~~ [capability means] and said proper subsets to optimize said network
125 further comprises:
126 using max-SINR null- and beam-steering to minimize intra-network interference.
127
128
- 129 5. (currently amended) A method as in claim 1, wherein dynamically adapting the
130 diversity ~~channels~~ [capability means] and said proper subsets to optimize said network
131 further comprises:
132 using MMSE null- and beam-steering to minimize intra-network interference.
133
134
- 135 6. (currently amended) A method as in claim 1, wherein dynamically adapting the
136 diversity ~~channels~~ [capability means] and said proper subsets to optimize said network
137 further comprises:
138
139 designing the network such that reciprocal symmetry exists for each pairing of
140 uplink receive and downlink receive proper subsets.
141
- 142 7. (currently amended) A method as in claim 1, wherein dynamically adapting the
143 diversity ~~channels~~ [capability means] and said proper subsets to optimize said network
144 further comprises:
145
146 designing the network such that substantial reciprocal symmetry exists for each
147 pairing of uplink receive and downlink receive proper subsets.
148
- 149 8. (original) A method as in claim 1, wherein the network uses TDD communication
150 protocols.
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- 152 9. (original) A method as in claim 1, wherein the network uses FDD communication
153 protocols.

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155 10. (original) A method as in claim 3, wherein the network uses simplex communication
156 protocols.

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158 11. (original) A method as in claim 1, wherein the network uses random access packets,
159 and receive and transmit operations are all carried out on the same frequency channels for
160 each link.

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162 12. (currently amended) A method as in claim 1, wherein dynamically adapting the
163 diversity channels [capability means] and said proper subsets to optimize said network
164 further comprises

165
166 if the received interference is spatially white in both link directions, setting
167 $\mathbf{g}_1(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_2(q) \propto \mathbf{w}_1^*(q)$
168 [$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$] at both ends of the link,
169 where $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$
170 [$\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$] are the linear transmit and receive weights used in the
171 downlink;

172
173 but if the received interference is not spatially white in both link directions,
174 constraining $\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$ $\{\mathbf{g}_1(q)\}$ and [$\{\mathbf{g}_2(q)\}$] to
175 preferentially satisfy:

176
177 $Q_{21} \quad N_4$
178 $\sum_{q=1}^Q \mathbf{g}_1^T(q) \mathbf{R}_{H,H} [\mathbf{n}_1(q)] \mathbf{g}_1^*(q) = \sum_{n=1}^N \text{Tr} \{ \mathbf{R}_{H,H}(n) \} = M_1 R_4$
179 $q=1 \quad n=1$
180

$$\sum g^T_2(q) R_{i2i2}[n_2(q)] g^*_2(q) = \sum \text{Tr}\{R_{i2i2}(n)\} = M_2 R_2.$$

183 q=1 n=1

184 □

$$185 \quad \sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{\mathbf{i}_1 \mathbf{i}_1}(n_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{\mathbf{i}_1 \mathbf{i}_1}(n)\} = M_1 R_1$$

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$$187 \quad \sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{\mathbf{i}_2 \mathbf{i}_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{\mathbf{i}_2 \mathbf{i}_2}(n)\} = M_2 R_2 \quad].$$

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190 13. (currently amended) A method as in claim 1, wherein:

191 a proper subset may incorporate one or more nodes that are in a receive-only
192 mode for every diversity channel [capability means].

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195 14. (original) A method as in claim 1, wherein:

the network may dynamically reassign a node from one proper subset to another.

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199 15. (original) A method as in claim 1, wherein:

the network may dynamically reassign a proper subset of nodes from one proper subset to another.

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204 16. (currently amended) A method as in claim 7, wherein the step of designing the
205 network such that substantial reciprocal symmetry exists for the uplink and downlink
206 channels further comprises:

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208 if the received interference is spatially white in both link directions, setting

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210 ~~$\mathbf{g}_1(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_2(q) \propto \mathbf{w}_1^*(q)$~~

211 [$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$] at both ends of the link,

212 where ~~{ $\mathbf{g}_2(q), \mathbf{w}_1(q)$ }~~ [{ $\mathbf{g}_2(q), \mathbf{w}_1(q)$ }] are the linear transmit
213 and receive weights used in the downlink;

214

215 but if the received interference is not spatially white in both link directions,

216 constraining ~~{ $\mathbf{g}_1(q)$ }~~ and ~~{ $\mathbf{g}_2(q)$ }~~ [{ $\mathbf{g}_1(q)$ } and { $\mathbf{g}_2(q)$ }] to
217 preferentially satisfy:

218

219 $\mathbf{Q}_{21} \xrightarrow{\quad\quad\quad} \mathbf{N}_1$

220 $\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1 i_1} [\mathbf{n}_1(q)] \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = \mathbf{M}_1 \mathbf{R}_1$

221 $\mathbf{q} = 1 \xrightarrow{\quad\quad\quad} \mathbf{n} = 1$

222

223 $\mathbf{Q}_{12} \xrightarrow{\quad\quad\quad} \mathbf{N}_2$

224 $\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2} [\mathbf{n}_2(q)] \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = \mathbf{M}_2 \mathbf{R}_2$

225 $\mathbf{q} = 1 \xrightarrow{\quad\quad\quad} \mathbf{n} = 1$

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228 $\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1 i_1} (\mathbf{n}_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = M_1 R_1$

229
$$\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{\mathbf{i}_2 \mathbf{i}_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{\mathbf{i}_2 \mathbf{i}_2}(n)\} = M_2 R_2$$
.

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232 17. (original) A method as in claim 1, wherein the means for digital signal processing in
233 said first subset of MIMO-capable nodes further comprises:

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235 an ADC bank for downconversion of received RF signals into digital signals;
236 a MT DEMOD element for multitone demodulation, separating the received
237 signal into distinct tones and splitting them into 1 through K_f feed FDMA
238 channels, said separated tones in aggregate forming the entire baseband for the
239 transmission, said MT DEMOD element further comprising

240 a Comb element with a multiple of 2 filter capable of operating on a 128-
241 bit sample; and,

242 an FFT element with a 1,024 real-IF function;

243 a Mapping element for mapping the demodulated multitone signals into a 426
244 active receive bins, wherein

245 each bin covers a bandwidth of 5.75MHz;

246 each bin has an inner passband of 4.26MHz for a content envelope;

247 each bin has an external buffer, up and down, of 745kHz;

248 each bin has 13 channels, CH0 through CH12, each channel having 320
249 kHz and 32 tones, T0 through T31, each tone being 10kHz, with the inner
250 30 tones being used information bearing and T0 and T31 being reserved;
251 each signal being 100μs, with 12.5μs at each end thereof at the front and
252 rear end thereof forming respectively a cyclic prefix and cyclic suffix
253 buffer to punctuate successive signals;

254 and,

255 a symbol-decoding element for interpretation of the symbols embedded in the
256 signal.

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260 18. (currently amended) A method as in claim 1, wherein dynamically adapting the
261 diversity channels [capability means] and said proper subsets to optimize said network
262 further comprises
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264 using at each node the receive combiner weights as transmit distribution weights
265 during subsequent transmission operations, so that the network is preferentially
266 designed and constrained such that each link is substantially reciprocal, such that
267 the ad hoc network capacity measure can be made equal in both link directions by
268 setting at both ends of the link:
269
270 ~~$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(k,q)$ and $\mathbf{g}_1(k,q) \propto \mathbf{w}_1^*(k,q)$~~
271 [$\mathbf{g}_2(k,q) \propto \mathbf{w}_2^*(k,q)$ and $\mathbf{g}_1(k,q) \propto \mathbf{w}_1^*(k,q)$],
272
273 where $\{\mathbf{g}_2(k,q), \mathbf{w}_2(k,q)\}$ [$\{\mathbf{g}_2(k,q), \mathbf{w}_1(k,q)\}$] are the
274 linear transmit and receive weights to transmit data $d_2(k,q)$ from node
275 $n_2(q)$ to node $n_1(q)$ over channel k in the downlink, and where
276 $\{\mathbf{g}_1(k,q), \mathbf{w}_1(k,q)\}$ are the linear transmit and receive weights used
277 to transmit data $d_1(k,q)$ from node $n_1(q)$ back to node $n_2(q)$ over
278 equivalent channel k in the uplink.
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282 19. (currently amended) A method as in claim 1, wherein the step of each node in a
283 transmit downlink / receive uplink subset having no more nodes with which it will hold

284 time and frequency coincident communications in its field of view, than it has diversity
285 capability [means] further comprises:

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287 designing the topological, physical layout of nodes to enforce this constraint
288 within the node's diversity channel means limitations.

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291 20. (currently amended) A method as in claim 1, wherein the step of each node in a
292 transmit uplink / receive downlink subset having no more nodes with which it will hold
293 time and frequency coincident communications in its field of view, than it has diversity
294 capability [means] further comprises:

295 designing the topological, physical layout of nodes to enforce this constraint
296 within the node's diversity channel means limitations.

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299 21. (currently amended) A method as in claim 1, wherein the step of dynamically
300 adapting the diversity channels [capability means] and said proper subsets to optimize
301 said network further comprises:

302 allowing a proper subset to send redundant data transmissions over multiple
303 frequency channels to another proper subset.

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306 22. (original) A method as in claim 1, wherein the step of dynamically adapting the
307 diversity channels [capability means] and said proper subsets to optimize said network
308 further comprises:

309 allowing a proper subset to send redundant data transmissions over multiple
310 simultaneous or differential time slots to another proper subset.

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313 23. (original) A method as in claim 1, wherein said transmitting proper subset and
314 receiving proper subset diversity capability means for transmission and reception of said
315 analog radio ~~waves~~ [signals] further comprise:

316 spatial diversity of antennae.

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319 24. (original) A method as in claim 1, wherein said transmitting proper subset and
320 receiving proper subset diversity capability means for transmission and reception of said
321 analog radio ~~waves~~ [signals] further comprise:

322 polarization diversity of antennae.

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325 25. (original) A method as in claim 1, wherein said transmitting proper subset and
326 receiving proper subset diversity capability means for transmission and reception of said
327 analog radio ~~waves~~ [signals] further comprise:

328 any combination of temporal, spatial, and polarization diversity of antennae.

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331 26. (currently amended) A method as in claim 1, wherein the step of dynamically
332 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
333 said network further comprises:

334 incorporating network control and feedback aspects as part of the signal encoding
335 process.

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338 27. (currently amended) A method as in claim 1, wherein the step of dynamically
339 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
340 said network further comprises:

341 incorporating network control and feedback aspects as part of the signal encoding
342 process and including said as network information in one direction of the
343 signalling and optimization process, using the perceived environmental

344 condition's effect upon the signals in the other direction of the signalling and
345 optimization process.

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348 28. (currently amended) A method as in claim 1, wherein the step of dynamically
349 adapting the diversity **channels** [capability means] and said proper subsets to optimize
350 said network further comprises:

351 adjusting the diversity **channel** [capability means] use between any proper sets of
352 nodes by rerouting any active link based on perceived unacceptable SINR
353 experienced on that active link and the existence of an alternative available link
354 using said adjusted diversity **channel** [capability means].

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357 29. (currently amended) A method as in claim 1, wherein the step of dynamically
358 adapting the diversity **channels** [capability means] and said proper subsets to optimize
359 said network further comprises:

360 switching a particular node from one proper subset to another due to changes in
361 the external environment affecting links between that node and other nodes in the
362 network.

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365 30. (currently amended) A method as in claim 1, wherein the step of dynamically
366 adapting the diversity **channels** [capability means] and said proper subsets to optimize
367 said network further comprises:

368 dynamically reshuffling proper subsets to more closely attain network objectives
369 by taking advantage of diversity channel availability.

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372 31. (currently amended) A method as in claim 1, wherein the step of dynamically
373 adapting the diversity **channels** [capability means] and said proper subsets to optimize
374 said network further comprises:

375 dynamically reshuffling proper subsets to more closely attain network objectives
376 by accounting for node changes.

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379 32. (currently amended) A method as in claim 31, wherein said node changes
380 include any of:

381 adding diversity capability [means] to a node, adding a new node within the field
382 of view of another node, removing a node from the network (temporarily or
383 permanently), or losing diversity capability [means] at a node.

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386 33. (currently amended) A method as in claim 1, wherein the step of dynamically
387 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
388 said network further comprises:

389 suppressing unintended recipients or transmitters by the imposition of signal
390 masking.

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393 34. (original) A method as in claim 33, wherein the step of suppressing unintended
394 recipients or transmitters by the imposition of signal masking further comprises:
395 imposition of an origination mask.

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398 34. (original) A method as in claim 33, wherein the step of suppressing unintended
399 recipients or transmitters by the imposition of signal masking further comprises:
400 imposition of a recipient mask.

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403 35. (original) A method as in claim 33, wherein the step of suppressing unintended
404 recipients or transmitters by the imposition of signal masking further comprises:
405 imposition of any combination of origination and recipient masks.

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408 36. (currently amended) A method as in claim 33, wherein the step of dynamically
409 adapting the diversity channels [capability means] and said proper subsets to optimize
410 said network further comprises:

411 using signal masking to secure transmissions against unintentional, interim
412 interception and decryption by the imposition of a signal mask at origination, the
413 transmission through any number of intermediate nodes lacking said signal mask,
414 and the reception at the desired recipient which possesses the correct means for
415 removal of the signal mask.

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418 37. (original) A method as in claim 36, wherein the signal masking is shared by a proper
419 subset.

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422 38. (currently amended) A method as in claim 1, wherein the step of dynamically
423 adapting the diversity channels [capability means] and said proper subsets to optimize
424 said network further comprises:

425 heterogenous combination of a hierarchy of proper subsets, one within the other,
426 each paired with a separable subset wherein the first is a transmit uplink and the
427 second is a transmit downlink subset, such that the first subset of each pair of
428 subsets is capable of communication with the members of the second subset of
429 each pair, yet neither subset may communicate between its own members.

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432 39. (original) A method as in claim 1, wherein the step of dynamically adapting the
433 diversity channels [capability means] and said proper subsets to optimize said network
434 further comprises:

435 using as many of the available diversity ~~channels~~ [capability means] as are needed
436 for traffic between any two nodes from 1 to NumChannels, where NumChannels
437 equals the maximal diversity capability [means] between said two nodes.

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439 40. (original) A method as in claim 1, wherein the step of dynamically adapting the
440 diversity ~~channels~~ [capability means] and said proper subsets to optimize said network
441 further comprises:

442 ~~usng~~ [using] a water-filling algorithm to route traffic between an origination and
443 destination node through any intermediate subset of nodes that has available
444 diversity ~~channel~~ [capability means] capacity.

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447 41. (currently amended) A method for optimizing a wireless electromagnetic
448 communications network, comprising:

449 a wireless electromagnetic communications network, comprising

450 a set of nodes, said set further comprising,

451 at least a first subset of MIMO-capable nodes, each MIMO-
452 capable node comprising:

453 a spatially diverse antennae array of $M[M]$ antennae, where
454 $M[M] \geq$ two, said antennae array being polarization
455 diverse, and circularly symmetric, and providing 1-to-M
456 RF feeds;

457 a transceiver for each antenna in said array, said transceiver
458 further comprising

459 a Butler Mode Forming element, providing spatial
460 signature separation with a FFT-LS algorithm,
461 reciprocally forming a transmission with shared
462 receiver feeds, such that the number of modes out
463 equals the numbers of antennae, establishing such
464 as an ordered set with decreasing energy, further
465 comprising:

466 a dual-polarization element for splitting the
467 modes into positive and negative polarities
468 with opposite and orthogonal polarizations,
469 that can work with circular polarizations,
470 and
471 a dual-polarized link CODEC;
472 a transmission/reception switch comprising,
473 a vector OFDM receiver element;
474 a vector OFDM transmitter element;
475 a LNA bank for a receive signal, said LNA
476 Bank also instantiating low noise
477 characteristics for a transmit signal;
478 a PA bank for the transmit signal that
479 receives the low noise characteristics for
480 said transmit signal from said LNA bank;
481 an AGC for said LNA bank and PA bank;
482 a controller element for said
483 transmission/reception switch enabling
484 baseband link distribution of the energy over
485 the multiple RF feeds on each channel to
486 steer up to $K[K]_{\text{feed}}$ beams and nulls
487 independently on each FDMA channel;
488 a Frequency Translator;
489 a timing synchronization element controlling
490 said controller element;
491 further comprising a system clock,
492 a universal Time signal element;
493 GPS;
494 a multimode power management element
495 and algorithm;
496 and,

528 used information bearing and T0 and
529 T31 being reserved;
530 each signal being $100\mu\text{s}$ [100 μs],
531 with $12.5\mu\text{s}$ [12.5 μs] at each end
532 thereof at the front and rear end
533 thereof forming respectively a cyclic
534 prefix and cyclic suffix buffer to
535 punctuate successive signals;
536 a MUX element for timing modification
537 capable of element-wise multiplication
538 across the signal, which halves the number
539 of bins and tones but repeats the signal for
540 high-quality needs;
541 a link CODEC, which separates each FDMA
542 channel into 1 through M [M] links, further
543 comprising
544 a SOVA bit recovery element;
545 an error coding element;
546 an error detection element;
547 an ITI remove element;
548 a tone equalization element;
549 and,
550 a package fragment retransmission
551 element;
552 a multilink diversity combining element,
553 using a multilink Rx weight adaptation
554 algorithm for Rx signal weights $\mathbf{W}(k)$
555 [$\mathbf{W}(k)$] to adapt transmission gains
556 $\mathbf{G}(k)$ [$\mathbf{G}(k)$] for each channel k [k];

557 an equalization algorithm, taking the signal
558 from said multilink diversity combining
559 element and controlling a delay removal
560 element;
561 said delay removal element separating signal
562 content from imposed pseudodelay and
563 experienced environmental signal delay, and
564 passing the content-bearing signal to a
565 symbol-decoding element;
566 said symbol-decoding element for
567 interpretation of the symbols embedded in
568 the signal, further comprising:
569 an element for delay gating;
570 a QAM element; and
571 a PSK element;
572 said vector OFDM transmitter element comprising:
573 a DAC bank for conversion of digital signals
574 into RF signals for transmission;
575 a MT MOD element for multitone
576 modulation, combining and joining the
577 signal to be transmitted from 1 through
578 $K[K]_{\text{feed}}$ FDMA channels, said separated
579 tones in aggregate forming the entire
580 baseband for the transmission, said MT
581 MOD element further comprising
582 a Comb element with a multiple of 2
583 filter capable of operating on a 128-
584 bit sample; and,
585 an IFFT element with a 1,024 real-IF
586 function;

587 a Mapping element for mapping the
588 modulated multitone signals from 426
589 active transmit bins, wherein
590 each bin covers a bandwidth of
591 ~~5.75MHz~~ [5.75 MHz];
592 each bin has an inner passband of
593 ~~4.26MHz~~ [4.26 MHz] for a content
594 envelope;
595 each bin has an external buffer, up
596 and down, of ~~745kHz~~ [745 kHz];
597 each bin has 13 channels, CH0
598 through CH12, each channel having
599 320 kHz and 32 tones, T0 through
600 T31, each tone being ~~10kHz~~ [10
601 kHz], with the inner 30 tones being
602 used information bearing and T0 and
603 T31 being reserved;
604 each signal being ~~100μs~~ [100 μs],
605 with ~~12.5μs~~ [12.5 μs] at each end
606 thereof at the front and rear end
607 thereof forming respectively a cyclic
608 prefix and cyclic suffix buffer to
609 punctuate successive signals;
610 a MUX element for timing modification
611 capable of element-wise multiplication
612 across the signal, which halves the number
613 of bins and tones but repeats the signal for
614 high-quality needs;
615 a symbol-coding element for embedding the
616 symbols to be interpreted by the receiver in
617 the signal, further comprising:

648 said set of nodes being deployed according to design rules that prefer
649 meeting the following criteria:

650 said set of nodes further comprising two or more proper subsets of
651 nodes, with a first proper subset being the transmit uplink / receive
652 downlink set, and a second proper subset being the transmit
653 downlink / receive uplink set;

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655 each node in said set of nodes belonging to no more transmitting
656 uplink or receiving uplink subsets than it has diversity capability
657 means;

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659 each node in a transmit uplink / receive downlink subset has no
660 more nodes with which it will hold time and frequency coincident
661 communications in its field of view, than it has diversity capability
662 [means];

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664 each node in a transmit downlink / receive uplink subset has no
665 more nodes with which it will hold time and frequency coincident
666 communications in its field of view, than it has diversity capability
667 [means];

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669 each member of a transmit uplink / receive downlink subset cannot
670 hold time and frequency coincident communications with any
671 other member of that transmit uplink / receive downlink subset;

672

673 and,

674

675 each member of a transmit downlink / receive uplink subset cannot
676 hold time and frequency coincident communications with any
677 other member of that transmit downlink / receive uplink subset;

678

679 transmitting, in said wireless electromagnetic communications network,
680 independent information from each node belonging to a first proper subset, to one
681 or more receiving nodes belonging to a second proper subset that are viewable
682 from the transmitting node;

683

684 processing independently, in said wireless electromagnetic communications
685 network, at each receiving node belonging to said second proper subset,
686 information transmitted from one or more nodes belonging to said first proper
687 subset;

688

689 and,

690

691 designing the network such that substantially reciprocal symmetry exists for the
692 uplink and downlink channels by,

693 if the received interference is spatially white in both link directions, setting
694

695 ~~$\mathbf{g}_1(a) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_2(q) \propto \mathbf{w}_1^*(q)$~~

696 [$\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)$] at both ends of the

697 link, where ~~{ $\mathbf{g}_2(q), \mathbf{w}_1(q)$ }~~ [{ $\mathbf{g}_2(q), \mathbf{w}_1(q)$ }] are the linear
698 transmit and receive weights used in the downlink;

699

700 but if the received interference is not spatially white in both link
701 directions, constraining ~~{ $\mathbf{g}_1(q)$ }~~ and ~~{ $\mathbf{g}_2(q)$ }~~
702 [{ $\mathbf{g}_1(q)$ } and { $\mathbf{g}_2(q)$ }] to satisfy:

703

704 \mathbf{Q}_{24}

705 $\sum \mathbf{g}_1^T(q) \mathbf{R}_{4444} [\mathbf{n}_4(q)] \mathbf{g}_1^*(q) =$

706 $\sum_{q=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1i_1}(n)\} = M_1 R_1$
 707
 708
 709 $\sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2i_2}(n)\} = M_2 R_2$
 710
 711 $\sum_{q=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1i_1}(q)\} = M_1 R_1$
 712
 713
 714
 715
 716
 717
 718 [
 719
$$\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1i_1}(n_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1i_1}(n)\} = M_1 R_1$$

 720
 721
$$\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2i_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2i_2}(n)\} = M_2 R_2]$$

 722
 723 using any standard communications protocol, including TDD, FDD, simplex,
 724
 725 and,
 726
 727 optimizing the network by dynamically adapting the diversity **channels** [capability
 728 means] between nodes of said transmitting and receiving subsets.
 729

730

731

732 42. (original) A method as in claim 41, wherein said a transmission/reception switch
733 further comprises:

734

735 an element for tone and slot interleaving.

736

737 43. (original) A method as in claim 41, wherein said TMC codec and SOVA decoder are
738 replaced with a Turbo codec.

739

740 44. (currently amended) A method as in claim 1, wherein the step of
741 dynamically adapting the diversity ~~channels~~ [capability means] and said proper subsets to
742 optimize said network further comprises:
743 optimizing at each node acting as a receiver the receive weights using ~~the~~ [a]
744 MMSE technique to adjust the multitone transmissions between it and other
745 nodes.

746

747

748 45. (currently amended) A method as in claim 1, wherein the step of dynamically
749 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
750 said network further comprises:
751 optimizing at each node acting as a receiver the receive weights using the ~~MAX~~
752 [maximum] SINR to adjust the multitone transmissions between it and other
753 nodes.

754

755

756 46. (currently amended) A method as in claim 1, wherein the step of dynamically
757 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
758 said network further comprises:
759 optimizing at each node acting as a receiver the receive weights, then optimizing
760 the transmit weights at that node by making them proportional to the receive

761 weights, and then optimizing the transmit gains for that node by a max-min
762 criterion for the link capacities for that node at that particular time.

763

764

765 47. (currently amended) A method as in claim 1, wherein the step of dynamically
766 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
767 said network further comprises:

768 including, as part of said network, one or more network controller elements that
769 assist in tuning local node's maximum ~~capaci~~ [capacity] criteria and link
770 channel diversity usage to network constraints.

771

772

773 48. (currently amended) A method as in claim 1, wherein the step of dynamically
774 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
775 said network further comprises:

776 characterizing the channel response vector $\mathbf{a}_1(f,t;n_2, n_1)$ by the observed
777 (possibly time-varying) azimuth and elevation $\{\theta_1(t;n_2, n_1),$
778 $\varphi_1(f,t;n_2, n_1)\}$ of node n_2 observed at n_1 .

779

780 49. (currently amended) A method as in claim 1, wherein the step of dynamically
781 adapting the diversity ~~channels~~ [capability means] and said proper subsets to optimize
782 said network further comprises:

783 characterizing the channel response vector $\mathbf{a}_1(f,t;n_2, n_1)$ as a superposition of
784 direct-path and near-field reflection path channel responses, e.g., due to scatterers
785 in the vicinity of n_1 , such that each element of $\mathbf{a}_1(f,t;n_2, n_1)$ can be modeled
786 as a random process, possibly varying over time and frequency.

787

788 50. (currently amended) A method as in claim 1, wherein the step of dynamically
789 adapting the diversity channels [capability means] and said proper subsets to optimize
790 said network further comprises:

791 presuming that $\mathbf{a}_1(f, t; n_2, n_1)$ and $\mathbf{a}_1(f, t; n_{2[1]}, n_{4[2]})$ can be
792 substantively time invariant over significant time durations, e.g., large numbers of
793 OFDM symbols or TDMA time frames, and inducing the most significant
794 frequency and time variation by the observed timing and carrier offset on each
795 link.

796

797

798 51. (currently amended) A method as in claim 1, wherein the step of dynamically
799 adapting the diversity channels [capability means] and said proper subsets to optimize
800 said network further comprises:

801 in such networks, e.g., TDD networks, wherein the transmit and receive
802 frequencies are identical ($f_{21}(k) = f_{12}(k) = f(k)$) and the transmit and
803 receive time slots are separated by short time intervals ($t_{21}(l) = t_{12}(l) + \Delta_{21}$
804 $\approx t(l)$), and $\mathbf{H}_{21}(k, l)$ and $\mathbf{H}_{21}(k, l)$. [$\mathbf{H}_{21}(k, l)$ and
805 $\mathbf{H}_{12}(k, l)$] become substantively reciprocal, such that the subarrays
806 comprising $\mathbf{H}_{21}(k, l)$ and $\mathbf{H}_{21}(k, l)$. [$\mathbf{H}_{21}(k, l)$ and $\mathbf{H}_{12}(k, l)$
807] satisfy $\mathbf{H}_{21}(k, l; n_2, n_1) \approx \delta_{21}(k, l; n_1, n_2) \mathbf{H}_{12}^T [\mathbf{H}_{12}^T](k, l$
808 ; $n_1, n_2)$, where $\delta_{21}(k, l; n_1, n_2)$ is a unit-magnitude, generally
809 nonreciprocal scalar, equalizing the observed timing offsets, carrier offsets, and
810 phase offsets, such that $\lambda_{21}(n_2, n_1) \approx \lambda_{12}(n_1, n_2)$, $\tau_{21}(n_2, n_1) \approx$
811 $\tau_{12}(n_{2[1]}, n_{4[2]})$, and $\nu_{21}(n_1, n_2) \approx \nu_{12}(n_{2[1]}, n_{4[2]})$, by
812 synchronizing each node to an external, universal time and frequency standard,

813 obtaining $\delta_{21}(k, l; n_{4[2]}, n_{2[1]}) \approx 1$, and establishing network channel
814 response as truly reciprocal $\mathbf{H}_{21}(k, l) \approx \mathbf{H}_{21}^T [\mathbf{H}_{12}^T](k, l)$.

815
816
817 52. A method as in claim 51, wherein the synchronization of each node is to Global
818 Position System Universal Time Coordinates (GPS UTC).

819
820
821 53. (original) A method as in claim 51, wherein the synchronization of each node is to a
822 network timing signal.

823
824
825 54. (original) A method as in claim 51, wherein the synchronization of each node is to a
826 combination of Global Position System Universal Time Coordinates (GPS UTC) and a
827 network timing signal.

828
829
830 55. (currently amended) A method as in claim 1, wherein the step of dynamically
831 adapting the diversity channels [capability means] and said proper subsets to optimize
832 said network further comprises:

833 for such parts of the network where the internode channel responses possess
834 substantive multipath, such that $\mathbf{H}_{21}(k, l; n_2, n_1)$ and $\mathbf{H}_{21[12]}(k, l
835 ; n_{2[1]}, n_{4[2]})$ have rank greater than unity, making the channel response
836 substantively reciprocal by:

837
838 (1) forming uplink and downlink transmit signals using the matrix formula
839 in EQ. 40

840 $\mathbf{s}_1(k, l; n_1) = \mathbf{G}_1(k, l; n_1) \mathbf{d}_1(k, l; n_1)$

841 $\mathbf{s}_2(k, l; n_1) = \mathbf{G}_2(k, l; n_2) \mathbf{d}_2(k, l; n_2);$

842 (2) reconstructing the data intended for each receive node using the
843 matrix formula in EQ. 41

844 $\mathbf{y}_1(k, l; n_1) = \mathbf{W}_1^H(k, l; n_1) \mathbf{x}_1(k, l; n_1)$

845 $\mathbf{y}_2(k, l; n_2) = \mathbf{W}_2^H(k, l; n_2) \mathbf{x}_2(k, l; n_2);$

846 (3) developing combiner weights that $\{\mathbf{w}_1(k, l; n_2, n_1)\}$ and
847 $\{\mathbf{w}_2(k, l; n_1, n_2)\}$ that substantively null data intended for
848 recipients during the symbol recovery operation, such that for $n_1 \neq n_2$:

849 (4) developing distribution weights $\{\mathbf{g}_1(k, l; n_2, n_1)\}$ and
850 $\{\mathbf{g}_2(k, l; n_1, n_2)\}$ that perform equivalent substantive nulling
851 operations during transmit signal formation operations;

852 (5) scaling distribution weights to optimize network capacity and/or power
853 criteria, as appropriate for the specific node topology and application
854 addressed by the network;

855 (6) removing residual timing and carrier offset remaining after recovery of
856 the intended network data symbols;

857 and

858 (7) encoding data onto symbol vectors based on the end-to-end SINR
859 obtainable between each transmit and intended recipient node, and
860 decoding that data after symbol recovery operations, using channel coding
861 and decoding methods develop in prior art.

862
 863 56. (currently amended) A method as in claim 1, wherein dynamically adapting the
 864 diversity ~~channels~~ [capability means] and said proper subsets to optimize said network
 865 further comprises:
 866 forming substantively nulling combiner weights using an FFT-based least-squares
 867 algorithms that adapt $\{\mathbf{w}_1(k, l; n_2, n_1)\}$ and $\{\mathbf{w}_2(k, l; n_1, n_2)\}$ to
 868 values that minimize the mean-square error (MSE) between the combiner output
 869 data and a known segment of transmitted pilot data;
 870 applying the pilot data to an entire OFDM symbol at the start of an adaptation
 871 frame comprising a single OFDM symbol containing pilot data followed by a
 872 stream of OFDM symbols containing information data;
 873 wherein the pilot data transmitted over the pilot symbol is preferably given by
 874 ~~EQ. 44 and EQ. 45,~~
 875
$$p_1(k; n_2, n_1) = d_1(k, 1; n_2, n_1)$$

 876
$$= p_{01}(k) p_{21}(k; n_2) p_{11}(k; n_1)$$

 877
$$p_2(k; n_1, n_2) = d_2(k, 1; n_1, n_2)$$

 878
$$= p_{02}(k) p_{12}(k; n_1) p_{22}(k; n_2)$$

 879 such that the “pseudodelays” $\delta_1(n_1)$ and $\delta_2(n_2)$ are unique to each transmit
 880 node (in small networks), or provisioned at the beginning of communication with
 881 any given recipient node (in which case each will be a function of n_1 and n_2),
 882 giving each pilot symbol a pseudorandom component;

883 maintaining minimum spacing between any pseudodelays used to communicate
884 with a given recipient node that is larger than the maximum expected timing
885 offset observed at that recipient node, said spacing should also being an integer
886 multiple of $1/K$, where K is the number of tones used in a single FFT-based LS
887 algorithm;

888 and if K is not large enough to provide a sufficiency of pseudodelays, using
889 additional OFDM symbols for transmission of pilot symbols, either lengthening
890 the effective value of K , or reducing the maximum number of originating nodes
891 transmitting pilot symbols over the same OFDM symbol;

892 also providing K large enough to allow effective combiner weights to be
893 constructed from the pilot symbols alone;

894 then obtaining the remaining information-bearing symbols, which are the uplink
895 and downlink data symbols provided by prior encoding, encryption, symbol
896 randomization, and channel preemphasis stages, in the adaptation frame, by
897 [using] ~~EQ. 46 and EQ. 47~~

898
$$d_1(k, l; n_2, n_1) = p_1(k; n_2, n_1) d_{01}(k, l; n_2, n_1)$$

899
$$d_2(k, l; n_1, n_2) = p_2(k; n_1, n_2) d_{02}(k, l; n_1, n_2);$$

900 removing at the recipient node, first the pseudorandom pilot components from the
901 received data by multiplying each tone and symbol by the pseudorandom
902 components of the pilot signals, using ~~EQ. 47 and EQ. 48~~

903
$$d_2(k, l; n_1, n_2) = p_2(k; n_1, n_2) d_{02}(k, l; n_1, n_2)$$

904
$$\mathbf{x}_{02}(k, l; n_2) = c_{01}(k; n_2) \mathbf{x}_2(k, l; n_2);$$

905 thereby transforming each authorized and intended pilot symbol for the recipient
906 node into a complex sinusoid with a slope proportional to the sum of the
907 pseudodelay used during the pilot generation procedure, and the actual observed
908 timing offset for that link, and leaving other, unauthorized pilot symbols, and
909 symbols intended for other nodes in the network, untransformed and so appearing
910 as random noise at the recipient node.

911

912

913 57. (currently amended) A method as in claim 55, wherein the FFT-Least Squares
914 algorithm ~~is that shown in Figure 37.~~ [further comprises:

915 using a pilot symbol, which is multiplied by a unit-norm FFT window function;
916 passing that result to a QR decomposition algorithm and computing orthogonalized
917 data $\{\mathbf{q}(k)\}$ and an upper-triangular Cholesky statistics matrix \mathbf{R} ;

918 then multiplying each vector element of $\{\mathbf{q}(k)\}$ by the same unit-norm FFT
919 window function and passing it through a zero-padded inverse Fast Fourier
920 Transform (IFFT) with output length PK , with padding factor P to form

921 uninterpolated, spatially whitened processor weights $\{\mathbf{u}(m)\}$, where lag index
922 m is proportional to target pseudodelay $\delta(m) = m/PK$;

923 then using the spatially whitened processor weights to estimate the mean-square-
924 error (MSE) obtaining for a signal received at each target pseudodelay,

925 $\varepsilon(m) = 1 - \|\mathbf{u}(m)\|^2$, yielding a detection statistic (pseudodelay indicator
926 function), with an extreme at IFFT lags commensurate with the observed
927 pseudodelay and designed to minimize interlag interference between pilot signal
928 features in the pseudodelay indicator function;

929 using an extremes-finding algorithm to detect each extreme;
930 estimating the location of the observed pseudodelays to sub-lag accuracy;
931 determining additional ancillary statistics;

932 selecting the extremes beyond a designated MSE threshold;
933 interpolating spatially whitened weights \mathbf{U} from weights near the extremes;
934 using the whitened combiner weights \mathbf{U} to calculate both unwhitened combiner
935 weights $\mathbf{W} = \mathbf{R}^{-1}\mathbf{U}$ to be used in subsequent data recovery operations, and to
936 estimate the received channel aperture matrix $\mathbf{A} = \mathbf{R}^H\mathbf{U}$, to facilitate ancillary
937 signal quality measurements and fast network entry in future adaptation frames;
938 and, lastly,
939 using an estimated and optimized pseudodelay vector $\boldsymbol{\delta}_*$ to generate $\mathbf{c}_1(k) =$
940 $\exp\{-j2\pi\boldsymbol{\delta}_*k\}$ (conjugate of $\{p_{11}(k; n_1)\}$ during uplink receive
941 operations, and $\{p_{22}(k; n_2)\}$ during downlink receive operations), which is then
942 used to remove the residual observed pseudodelay from the information bearing
943 symbols.

944
945

946 58. (original) A method as in claim 55, wherein the pseudodelay estimation is refined
947 using a Gauss-Newton recursion using the approximation :

948 $\exp\{-j2\pi\Delta(k-k_0)/PK\} \approx 1 - j2\pi\Delta(k-k_0)/PK.$

949
950

951 59. (currently amended) A method as in claim 1, wherein wherein dynamically
952 adapting the diversity channels [capability means] and said proper subsets to optimize
953 said network further comprises:

954 using the linear combiner weights provided during receive operations are
955 construct linear distribution weights during subsequent transmit operations, by
956 setting distribution weight $\mathbf{g}_1(k, l; n_2, n_1)$ proportional to

957 $\mathbf{w}^*_1(k, l; n_2, n_1)$ during uplink transmit operations, and
958 $\mathbf{g}_2(k, l; n_1, n_2)$ proportional to $\mathbf{w}^*_2(k, l; n_1, n_2)$ during downlink
959 transmit operations; thereby making the transmit weights substantively nulling
960 and thereby allowing each node to form frequency and time coincident two-way
961 links to every node in its field of view, with which it is authorized (through
962 establishment of link set and transfer of network/recipient node information) to
963 communicate.

964

965

966 60. (original) A method as in claim 1, wherein each node in the first subset of nodes
967 further comprises:

968 a LEGO implementation element and algorithm.

969

970

971 61. (currently amended) A method as in claim 1, wherein dynamically adapting the
972 diversity channels [capability means] and said proper subsets to optimize said network
973 further comprises:

974 balancing the power use against capacity for each channel, link, and node, and
975 hence for the network as a whole by:

976 establishing a capacity objective $\mathbf{B} [\{ \beta(m) \}]$ for a particular Node 2
977 [user 2 node] receiving from [a user 1 node] another Node 1 as the target
978 to be achieved by the [user 2 node] node 2[;]
979 solving, at [the user 2 node] Node 2 the local optimization problem:

980 $\min \sum_q \pi_1(q) = [=] \mathbf{1}^T \boldsymbol{\pi}_1$, such that

981 $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$,

982 where $\pi_1(q)$ is the SU (user 1 node) transmit power for link
983 number q [Q] for the user 1 node,

984 $\gamma(q)$ is the signal to interference [and] noise ratio (SINR) seen at
 985 the output of the beamformer,
 986 **1** is a vector of all 1s,
 987 and,
 988 π_1 is a vector whose q^{th} element is $\pi_1(q)$ [q^{th} element is $\pi_1(q)$
 989],
 990 the aggregate set $Q(m)$ [$Q(m)$] contains a set of links that are
 991 grouped together for the purpose of measuring capacity flows
 992 through those links;
 993 using at ~~Node-2~~ [the user 2 node] the local optimization solution to
 994 moderate the transmit and receive weights, and signal information,
 995 returned to ~~node-1~~ [user 1 node];
 996 and,
 997 using said feedback to compare against the capacity objective B
 998 [$\beta(m)$] and incrementally adjust the transmit power at each of ~~Node~~
 999 + [the user 1 node] and ~~Node-2~~ [the user 2 node] until no further
 1000 improvement is perceptible.
 1001
 1002
 1003 62. (currently amended) A method as in claim 1, wherein dynamically adapting the
 1004 diversity channels [capability means] and said proper subsets to optimize said network
 1005 further comprises:
 1006 using the downlink objective function in ~~EQ. 5 and EQ. 6~~
 1007
$$\min \sum_q \pi_2(q) = \mathbf{1}^T \boldsymbol{\pi}_2 \text{ such that } \sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq$$

 1008 $\beta(m)$
 1009 at each node to perform local optimization;
 1010 reporting the required feasibility condition, $\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m)$

- 1011 $\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m)$];
- 1012 and,
- 1013 modifying $\beta(m)$ as necessary to stay within the constraint.
- 1014
- 1015
- 1016 63. (original) A method as in claim 60[61], wherein:
- 1017 the capacity constraints $\beta(m)$ are determined in advance for each proper subset
- 1018 of nodes, based on known QoS requirements for each said proper subset.
- 1019
- 1020
- 1021 64. (currently amended) A method as in claim 60[61], wherein said network further
- 1022 seeks to minimize total power in the network as suggested by EQ. 4
- 1023 $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m).$
- 1024
- 1025
- 1026 65. (currently amended) A method as in claim 60[61], wherein said network sets as
- 1027 a target objective for the network \mathbf{B} [$\{\beta(m)\}$] the QoS for the network.
- 1028
- 1029
- 1030 66. (currently amended) A method as in claim 60[61], wherein said network sets as
- 1031 a target objective for the network \mathbf{B} [$\{\beta(m)\}$] a vector of constraints.
- 1032
- 1033
- 1034 67. (currently amended) A method as in claim 60[61], wherein the local
- 1035 optimization problem is further defined such that:
- 1036

1037 the receive and transmit weights are unit normalized with respect to the
1038 background interference autocorrelation matrix;

1039

1040 the local SINR is expressed as ~~EQ.8~~ [

$$\gamma(q) = \frac{P_{rt}(q, q)\pi_t(q)}{1 + \sum_{j \neq q} P_{rt}(q, j)\pi_t(j)}$$

1041];

1042

1043 and the weight normalization ~~in EQ.6~~ [

$$\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)]$$

1044 is used to enable [$D_{12}(\mathbf{W}, \mathbf{G}) = D_{21}(\mathbf{G}^*, \mathbf{W}^*)$, where $(\mathbf{W}_2, \mathbf{G}_1)$
1045 and $(\mathbf{W}_1, \mathbf{G}_2)$ represent the receive and transmit weights employed by all
1046 nodes in the network during uplink and downlink operations, respectively,] the
1047 reciprocity equation at that node, thereby allowing the uplink and downlink
1048 function to be presumed identical rather than separately computed.

1049

1050

1051

1052 68. (currently amended) A method as in claim 60[61], wherein:

1053 very weak constraints to the transmit powers are approximated by using a very
1054 simple approximation for ~~$\gamma(q)$~~ [$\gamma(q)$].

1055

1056

1057 69. (currently amended) A method as in claim 60[61], for the cases wherein all the
1058 aggregate sets contain a single link and non-negligible environmental noise is present,
1059 wherein the transmit powers are computed as Perron vectors from ~~EQ.10~~, [

$$\begin{aligned}
 D_{21} &= \log\left(1 + \frac{1}{\rho(\mathbf{P}_{21}) - 1}\right) \\
 1060 \quad &= \log\left(1 + \frac{1}{\rho(\mathbf{P}_{12}^T) - 1}\right) \quad]; \\
 &= D_{12}
 \end{aligned}$$

1061 and a simple power constraint is imposed upon the transmit powers.

1062

1063

1064 70. (currently amended) A method as in claim 60[69], wherein the optimization is
1065 performed in alternating directions and repeated.

1066

1067

1068 71. (currently amended) A method as in claim 60[61], wherein each node presumes
1069 the post-beamforming interference energy remains constant for the adjustment interval
1070 and so solves EQ. 3 [

$$\min_{\pi_1(q)} \sum_q \pi_1(q) = \mathbf{1}^T \boldsymbol{\pi}_1, \text{ subject to the constraint of}$$

$$\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)]$$

1073 using classic water filling arguments based on Lagrange multipliers, and then uses a
1074 similar equation for the reciprocal element of the link.

1075

1076

1077 72. (currently amended) A method as in claim 60[61], wherein at each node the
1078 constrained optimization problem stated in EQ. 13 and 14 [

$$\max_m \sum_{q \in Q(m)} \log(1 + \gamma(q)), \text{ such that}$$

1080 $\sum_{q \in Q(m)} \pi_1(q) \leq R_1(m), \gamma(q) \geq 0$]

1081 is solved using the approximation in EQ. 11, [

1082
$$\gamma(q) = \frac{P_{21}(q, q)\pi_1(q)}{i_2(q)} \quad]$$

1083 and the network further comprises at least one high-level network controller that controls
 1084 the power constraints $R_1(q)$ [$R_1(m)$], and drives the network towards a max-min
 1085 solution.

1086

1087

1088 73. (currently amended) A method as in claim 60[61], wherein each node:

1089 is given an initial γ_0 ;

1090 generates the model expressed in EQ. 20, EQ. 21, and EQ. 22;

1091 updates the new γ_α from EQ. 23 and EQ. 24;

1092 determines a target SINR to adapt to;

1093 and,

1094 updates the transmit power for each link q according to ~~EQ. 25 and EQ. 26~~ [

1095
$$\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$$

1096
$$\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2 \quad].$$

1097

1098

1099 74. (currently amended) A method as in claim 60[61], for each node wherein the
 1100 transmit power relationship of ~~EQ. 25 and EQ. 26~~ [

1101
$$\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$$

1102 $\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2$]

1103 is not known, that:

1104 uses a suitably long block of N samples is used to establish the relationship, where
 1105 N is either 4 times the number of antennae or 128, whichever is larger;
 1106 uses the result to update the receive weights at each end of the link;
 1107 optimizes the local model as in ~~EQ. 23 and EQ. 24~~ [

1108 $\gamma_* = \arg \min_{\gamma} L(\gamma, \mathbf{g}, \beta)$

1109 $\gamma_\alpha = \gamma_0 + \alpha(\gamma_* - \gamma_0)$; and then applies [

1111 $\pi_2(q) = \gamma_\alpha i_1(q) / |h(q)|^2$

1112 $\pi_1(q) = \gamma_\alpha i_2(q) / |h(q)|^2$] ~~EQ. 25 and EQ. 26.~~

1113

1114

1115 75. (currently amended) A method as in claim 60[61] that, for an aggregate proper
 1116 subset m :

1117 for each node within the set m , inherits the network objective function model
 1118 given in ~~EQ. 28, EQ. 29, and EQ. 30~~ [

1119 $L_m(\gamma, \mathbf{g}, \beta) = \sum_{q \in Q(m)} \mathbf{g}_q \gamma(q)$

1120 $\sum_{q \in Q(m)} \log(1 + \gamma(q)) \geq \beta(m)$

1121 $g(q) = i_1(q)i_2(q) / |h(q)|^2$; eliminates the [a] step of matrix channel estimation, transmitting instead

1122 from that node as a single real number for each link to the other end of
 1123 said link an estimate of the post beamforming interference power;

1124 and ,

1126 receives back for each link a single real number being the transmit power.

1127

1128 76. (original) A method as in claim 75, that for each pair of nodes assigns to the one
1129 presently possessing the most processing capability the power management
1130 computations.

1131

1132

1133 77. (currently amended) A method as in claim 74[75] that estimates the transfer
1134 gains and the post beamforming interference power using simple least squares estimation
1135 techniques.

1136

1137

1138 78. (currently amended) A method as in claim 74[75] that, for estimating the transfer
1139 gains and post beamforming interference power:

1140

1141 instead solves for the transfer gain h using ~~EQ. 31~~

$$1142 [y(n) = hgs(n) + \varepsilon(n)];$$

1143 uses a block of N samples of data to estimate h using ~~EQ. 32-~~ [

$$1144 h = \frac{\sum_{n=1}^N s^*(n)y(n)}{\sum_{n=1}^N |s(n)|^2 g}$$

1145 obtains an estimation of residual interference power ~~R_e~~ [R_ε] using ~~EQ. 33-~~ [

$$1146 R_\varepsilon = \left\langle |\varepsilon(n)|^2 \right\rangle \\ = \frac{1}{N} \sum_{n=1}^N \left(|y(n)|^2 - |g h s(n)|^2 \right)$$

1147 and,

1148 obtains knowledge of the transmitted data symbols $S(n)$ from using

1149 remodulated symbols at the output of the codec.

1150

1151

1152 79. (currently amended) A method as in claim 77 [78] wherein, instead of obtaining

1153 knowledge of the transmitted data symbols $S(n)$ from using remodulated symbols at the

1154 output of the codec, the node uses the output of a property restoral algorithm used in a

1155 blind beamforming algorithm.

1156

1157

1158 80. (currently amended) A method as in claim 77 [78] wherein, instead of obtaining

1159 knowledge of the transmitted data symbols $S(n)$ from using remodulated symbols at the

1160 output of the codec, the node uses a training sequence explicitly transmitted to train

1161 beamforming weights and asset the power management algorithms.

1162

1163

1164 81. (currently amended) A method as in claim 77 [78] wherein, instead of obtaining

1165 knowledge of the transmitted data symbols $S(n)$ from using remodulated symbols at the

1166 output of the codec, the node uses any combination of:

1167 the output of a property restoral algorithm used in a blind beamforming algorithm;

1168 a training sequence explicitly transmitted to train beamforming weights and asset

1169 the power management algorithms;

1170 or,

1171 other means known to the art.

1172

1173

- 1174 82. (currently amended) A method as in claim 60[61], wherein each node
1175 incorporates a link level optimizer and a decision algorithm,~~as illustrated in Figure~~
1176 32Aand 32B.
- 1177
- 1178 83. (currently amended) A method as in claim 81[82], wherein the decision
1179 algorithm is a Lagrange multiplier technique.
- 1180
- 1181
- 1182 84. (currently amended) A method as in claim 60[61], wherein the solution to EQ. 3
1183 is implemented by a penalty function technique.
- 1184
- 1185
- 1186 85. (currently amended) A method as in claim 83[84], wherein the penalty function
1187 technique:
1188 takes the derivative of $\nabla_{\pi_1} [\mathcal{H}(q)]$ with respect to π_1 ;
1189 and,
1190 uses the Kronecker-Delta function and the weighted background noise.
- 1191
- 1192
- 1193 86. (currently amended) A method as in claim 83[84], wherein the penalty function
1194 technique neglects the noise term.
- 1195
- 1196
- 1197 87. (currently amended) A method as in claim 83[84], wherein the penalty function
1198 technique normalizes the noise term to one.
- 1199
- 1200
- 1201 88. (currently amended) A method as in claim 60[61], wherein the approximation
1202 uses the receive weights.
- 1203
- 1204

1205 89. (currently amended) A method as in claim 60[61], wherein adaptation to the
1206 target objective is performed in a series of measured and quantized descent and ascent
1207 steps.

1208

1209 90. (currently amended) A method as in claim 60[61], wherein the adaptation to the
1210 target objective is performed in response to information stating the vector of change.

1211

1212

1213 91. (currently amended) A method as in claim 60[61], which uses the log linear
1214 mode ~~in~~ EQ. 34 [

$$1215 \beta_q \approx \log\left(\frac{a \pi_1(q) + a_0}{b \pi_1(q) + b_0}\right) = \hat{\beta}_q(\pi_1(q))$$

1216 and the inequality characterization ~~in~~ EQ. 35 [$\hat{\beta}_q(\pi_1(q)) \geq \beta$] to solve the
1217 approximation problem with a simple low dimensional linear program.

1218

1219

1220 92. (currently amended) A method as in claim 60[61], develops the local mode by
1221 matching function values and gradients between the current model and the actual
1222 function.

1223

1224

1225 93. (currently amended) A method as in claim 60[61], which develops the model as
1226 a solution to the least squares fit, evaluated over several points.

1227

1228

1229 94. (currently amended) A method as in claim 60[61], which reduces the cross-
1230 coupling effect by allowing only a subset of links to update at any one particular time,
1231 wherein the subset members are chosen as those which are more likely to be isolated
1232 from one another.

- 1233
- 1234
- 1235
- 1236 95. (currently amended) A method as in claim 60[61], wherein:
- 1237 the network further comprises a network controller element;
- 1238 said network controller element governs a subset of the network;
- 1239 said network controller element initiates, monitors, and changes the target
- 1240 objective for that subset;
- 1241 said network controller communicates the target objective to each node in that
- 1242 subset;
- 1243 and,
- 1244 receives information from each node concerning the adaptation necessary to meet
- 1245 said target objective.
- 1246
- 1247
- 1248 96. (currently amended) A method as in claim 94[95], wherein said network further
- 1249 records the scalar and history of the increments and decrements ordered by the network
- 1250 controller.
- 1251
- 1252
- 1253 97. (currently amended) A method as in claim 60[61], wherein for any subset, a
- 1254 target objective may be a power constraint.
- 1255
- 1256
- 1257 98. (currently amended) A method as in claim 60[61], wherein for any subset, a
- 1258 target objective may be a capacity maximization subject to a power constraint.
- 1259
- 1260
- 1261 99. (currently amended) A method as in claim 60[61], wherein for any subset, a
- 1262 target objective may be a power minimization subject to the capacity attainment to the
- 1263 limit possible over the entire network.

1264

1265

1266 100. (currently amended) A method as in claim 60[61], wherein for any subset, a
1267 target objective may be a power minimization at each particular node in the network
1268 subject to the capacity constraint at that particular node.

1269

1270

1271 101. (currently amended) A wireless electromagnetic communications network,
1272 comprising:

1273 a wireless electromagnetic communications network, comprising

1274 a set of nodes, said set further comprising,

1275 at least a first subset wherein each node is MIMO-capable,

1276 comprising:

1277 a spatially diverse antennae array of M antennae, where M

1278 ≥ one,

1279 a transceiver for each antenna in said array,

1280 means for digital signal processing,

1281 means for coding and decoding data and symbols,

1282 means for diversity transmission and reception,

1283 and,

1284 means for input and output from and to a non-radio

1285 interface;

1286 said set of nodes further comprising one or more proper subsets of nodes,
1287 being at least one transmitting and at least one receiving subset, with said
1288 transmitting and receiving subsets having a topological arrangement
1289 whereby:

1290 each node in a transmitting subset has no more nodes with which it
1291 will simultaneously communicate in its field of view, than it has
1292 number of antennae;

1293 each node in a receiving subset has no more nodes with which it
1294 will simultaneously communicate in its field of view, than it can
1295 steer independent nulls to;
1296 and,
1297 each member of a non-proper subset cannot communicate with any
1298 other member of its non-proper subset;
1299 transmitting independent information from each node in a first non-proper subset
1300 to one or more receiving nodes belonging to a second non-proper subset that are
1301 viewable from the transmitting node;
1302 processing independently information transmitted to a receiving node in a second
1303 non-proper subset from one or more nodes in a first non-proper subset is
1304 independently by the receiving node;
1305 and,
1306 optimizing the network by dynamically adapting the **diversity channels** [means for
1307 diversity transmission and reception] between nodes of said transmitting and receiving
1308 subsets.

1309
1310
1311 102. (currently amended) An apparatus as in claim 100-[101], further
1312 comprising an element for scheduling according to a Demand-Assigned, Multiple-Access
1313 algorithm.

1314
1315
1316 103. (currently amended) An apparatus as in claim 100-[101], further comprising for
1317 each node in said first subset a LEGO adaptation element.

1318
1319
1320 104. (currently amended) An apparatus as in claim 100-[101], further comprising:
1321 for each node in said first subset a LEGO adaptation element; and,
1322 one or more network controllers.

1323

1324

1325 105. (currently amended) A method as in claim 1, wherein the step of dynamically
1326 adapting the diversity channels [capability means] and said proper subsets to optimize
1327 said network further comprises:

1328

1329 matching each transceiver's degrees of freedom (DOF) to the nodes in the
1330 possible link directions;

1331 equalizing those links to provide node-equivalent uplink and downlink capacity.

1332

1333 106. (original) A method as in claim 105, further comprising, after the DOF matching:
1334 assigning asymmetric transceivers to reflect desired capacity weighting;
1335 adapting the receive weights to form a solution for multipath resolutions;
1336 employing data and interference whitening as appropriate to the local conditions;
1337 and,
1338 using retrodirective transmission gains during subsequent transmission operations.

1339

1340

1341 107. (original) A method as in claim 105, wherein the receive weights are ~~similarly~~
1342 modified [matched to the nodes in the possible link directions].

1343

1344

1345 108. (currently amended) A method for optimizing a wireless electromagnetic
1346 communications network, comprising:
1347 a wireless electromagnetic communications network, comprising
1348 a set of nodes, said set of nodes further comprising,
1349 at least a first subset wherein each node is MIMO-capable,
1350 comprising:
1351 an antennae array of M [M] antennae, where M [M] \geq one,
1352 a transceiver for each antenna in said spatially diverse
1353 antennae array,

1354 means for digital signal processing to convert analog radio
1355 signals into digital signals and digital signals into analog
1356 radio signals,
1357 means for coding and decoding data, symbols, and control
1358 information into and from digital signals,
1359 diversity capability means for transmission and reception of
1360 said analog radio waves [signals];
1361 and,
1362 means for input and output from and to a non-radio
1363 interface for digital signals;
1364 said set of nodes being deployed according to design rules that prefer
1365 meeting the following criteria:
1366
1367 said set of nodes further comprising two or more proper subsets of
1368 nodes, with a first proper subset being the transmit uplink / receive
1369 downlink set, and a second proper subset being the transmit
1370 downlink / receive uplink set;
1371
1372 each node in said set of nodes belonging to no more transmitting
1373 uplink or receiving uplink subsets than it has diversity capability
1374 means;
1375
1376 each node in a transmit uplink / receive downlink subset has no
1377 more nodes with which it will hold time and frequency coincident
1378 communications in its field of view, than it has diversity capability
1379 [means];
1380
1381 each node in a transmit downlink / receive uplink subset has no
1382 more nodes with which it will hold time and frequency coincident
1383 communications in its field of view, than it has diversity capability
1384 [means];

1385
1386 each member of a transmit uplink / receive downlink subset cannot
1387 hold time and frequency coincident communications with any
1388 other member of that transmit uplink / receive downlink subset;
1389 and,
1390 each member of a transmit downlink / receive uplink subset cannot
1391 hold time and frequency coincident communications with any
1392 other member of that transmit downlink / receive uplink subset;
1393
1394 transmitting, in said wireless electromagnetic communications network,
1395 independent information from each node belonging to a first proper subset, to one
1396 or more receiving nodes belonging to a second proper subset that are viewable
1397 from the transmitting node;
1398
1399 processing independently, in said wireless electromagnetic communications
1400 network, at each receiving node belonging to said second proper subset,
1401 information transmitted from one or more nodes belonging to said first proper
1402 subset;
1403
1404 optimizing at the local level for each node for the channel capacity \mathbf{D} [D]₂₁
1405 according to EQ. 49, [

$$D_{21} = \max \beta \text{ such that}$$

$$\beta \leq \sum_{q \in U(m)} \sum_k \log(1 + \gamma(k, q)),$$

$$\gamma(k, q) \geq 0,$$

$$\sum_m R_1(m) \leq R,$$

$$\pi_1(k, q) \geq 0,$$

$$\sum_{q \in U(m)} \sum_k \pi_1(k, q) \leq R_1(m)$$

solving first the reverse link power control problem; then treating the forward link problem in an identical fashion, substituting the subscripts 2 for 1 in said equation;

1410 and,

1411 dynamically adapting the diversity channels [capability means] and said proper
1412 subsets to optimize said network.

1413

1414

1415 109. (currently amended) A method as in claim 108, further comprising:

1416

1417 for each aggregate subset m , attempting to achieve the given capacity objective, β

1418 [β], as described in [

$$1419 \quad [\min_{\pi_r(q)}] \sum_{q \in Q(m)} \pi_r(q), \quad \text{such that}$$

$$1420 \quad \beta = \sum_{q \in Q(m)} \log (1 + \gamma(q))$$

1421]

1422 EQ. 50, by:

(1) optimizing the receive beamformers, using simple MMSE processing, to simultaneously optimize the SINR;

1425 (2) based on the individual measured SINR for each q [Q] index, attempt to
1426 incrementally increase or lower its capacity as needed to match the current target;
1427 and,

1428 (3) step[*p*]ing the power by a quantized small step in the appropriate direction;
1429 then,

when all aggregate sets have achieved the current target capacity, then the network can either increase the target capacity β , or add additional users to exploit the now-known excess capacity

1433

1434

1435 110. (currently amended) A method as in claim 106[107], wherein instead of
1436 optimizing for channel [capability means] capacity, the network optimizes for QoS [and
1437 not diversity capability means capacity].

1438

1439 111. (currently amended) A method as in claim 94[95], wherein:

1440 said network controller adds, drops, or changes the target capacity for any node in
1441 the set the network controller controls.

1442

1443

1444 112. (currently amended) A method as in claim 94[95], wherein:

1445 said network controller may, either in addition to or in replacement for altering β ,
1446 add, drop, or change channels between nodes, frequencies, coding, security, or
1447 protocols, polarizations, or traffic density allocations usable by a particular node
1448 or channel.

1449

1450

1451 113. (currently amended) A wireless electromagnetic communications network,
1452 comprising:

1453 a set of nodes, said set further comprising,
1454 at least a first subset wherein each node is MIMO-capable,
1455 comprising:
1456 a spatially diverse antennae array of $M[M]$ antennae, where
1457 $M[M] \geq$ one,
1458 a transceiver for each antenna in said array,
1459 13 means for digital signal processing,
1460 14 means for coding and decoding data and symbols,
1461 19 means for diversity transmission and reception,
1462 pilot symbol coding & decoding element
1463 timing synchronization element
1464 and,
1465 means for input and output from and to a non-radio
1466 interface;
1467 said set of nodes further comprising two or more proper subsets of nodes,
1468 there being at least one transmitting and at least one receiving subset, with
1469 said transmitting and receiving subsets subset having a diversity
1470 arrangement whereby:
1471 each node in a transmitting subset has no more nodes with which it
1472 will simultaneously communicate in its field of view, than it has
1473 number of antennae;
1474 each node in a receiving subset has no more nodes with which it
1475 will simultaneously communicate in its field of view, than it can
1476 steer independent nulls to;
1477 and,
1478 each member of a non-proper subset cannot communicate with any
1479 other member of its non-proper subset over identical diversity
1480 channels;
1481 a LEGO adaptation element and algorithm;
1482 a network controller element and algorithm;

whereby each node in a first non-proper subset transmits independent information
 to one or more receiving nodes belonging to a second non-proper subset that are
 viewable from the transmitting node;
 each receiving node in said second non-proper subset processes independently
 information transmitted to it from one or more nodes in a first non-proper subset is
 independently by the receiving node;
 each node uses means to minimize SINR between nodes transmitting and
 receiving information;
 the network is designed such that substantially reciprocal symmetry exists for the
 uplink and downlink channels by,
 if the received interference is spatially white in both link directions, setting
 $\mathbf{g}_1(aq) \propto \mathbf{w}_2^*(q)$ and $\mathbf{g}_2(q) \propto \mathbf{w}_1^*(q)$
 $[\mathbf{g}_2(q) \propto \mathbf{w}_2^*(q) \text{ and } \mathbf{g}_1(q) \propto \mathbf{w}_1^*(q)]$ at both ends of the link,
 where $\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$ [$\{\mathbf{g}_2(q), \mathbf{w}_1(q)\}$] are the linear transmit
 and receive weights used in the downlink;
 but if the received interference is not spatially white in both link
 directions, constraining $\{\mathbf{g}_1(q)\}$ and $\{\mathbf{g}_2(q)\}$
 $[\{\mathbf{g}_1(q)\} \text{ and } \{\mathbf{g}_2(q)\}]$ to satisfy:

$$\sum_{q=1}^{Q_{24}} \mathbf{g}_1^T(q) \mathbf{R}_{1111} [\mathbf{n}_1(q)] \mathbf{g}_1^*(q) =$$

$$\frac{\sum_{q=1}^{N_1} \mathbf{g}_1^T(q) \mathbf{R}_{1111} [\mathbf{n}_1(q)] \mathbf{g}_1^*(q)}{N_1} =$$

$$\sum_{n=1}^{M_1} \text{Tr}\{\mathbf{R}_{1111}(n)\} = M_1 \mathbf{R}_{11}$$

$$\sum_{n=1}^{M_1} \mathbf{R}_{1111}(n) = M_1 \mathbf{R}_{11}$$

1509

\mathbf{Q}_{12}

1510

$$\sum \mathbf{g}_2^T(\mathbf{q}) \mathbf{R}_{i_2 i_2}[\mathbf{n}_2(\mathbf{q})] \mathbf{g}_2^*(\mathbf{q}) =$$

1511

$\mathbf{q} = 1$ _____

1512

$\mathbf{n} = 1$

1513

$$\sum \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2,$$

1514

N_2 [

1515

1516

$$\sum_{q=1}^{Q_{21}} \mathbf{g}_1^T(q) \mathbf{R}_{i_1 i_1}(n_1(q)) \mathbf{g}_1^*(q) = \sum_{n=1}^{N_1} \text{Tr}\{\mathbf{R}_{i_1 i_1}(n)\} = M_1 R_1$$

1517

$$\sum_{q=1}^{Q_{12}} \mathbf{g}_2^T(q) \mathbf{R}_{i_2 i_2}(n_2(q)) \mathbf{g}_2^*(q) = \sum_{n=1}^{N_2} \text{Tr}\{\mathbf{R}_{i_2 i_2}(n)\} = M_2 R_2$$

1518

];

1519

the network uses any standard communications protocol;

1520

and,

1521

the network is optimized by dynamically adapting the [means for diversity

1522

transmission and reception] **diversity channels** between nodes of said transmitting

1523

and receiving subsets.

1524

1525

1526

114. (currently amended) A wireless electromagnetic communications network as in

1527

claim 112[113]:

1528

wherein each node may further comprise a Butler Mode Forming element, to

1529

enable said node to ratchet the number of active antennae for a particular uplink

1530

or downlink operation up or down.

1531

1532

- 1533 115. (currently amended) A wireless electromagnetic communications network as in
1534 claim 50[101]:
1535 incorporating a dynamics-resistant multitone element.
- 1536
- 1537
- 1538 116. (original) The use of a method as described in claim 1 for fixed wireless
1539 electromagnetic communications.
- 1540
- 1541 117. (currently amended) The use of an apparatus as described in claim 50[101]for
1542 fixed wireless electromagnetic communications.
- 1543
- 1544 118. (original) The use of a method as described in claim 1 for mobile wireless
1545 electromagnetic communications.
- 1546
- 1547 119. (currently amended) The use of an apparatus as described in claim 50[101]for
1548 mobile wireless electromagnetic communications.
- 1549
- 1550 120. (original) The use of a method as described in claim 1 for mapping operations using
1551 wireless electromagnetic communications.
- 1552
- 1553 121. (currently amended) The use of an apparatus as described in claim 50[101]for
1554 mapping operations using wireless electromagnetic communications.
- 1555
- 1556 122. (original) The use of a method as described in claim 1 for a military wireless
1557 electromagnetic communications network.
- 1558
- 1559 123. (currently amended) The use of an apparatus as described in claim 50[101]for a
1560 military wireless electromagnetic communications network.
- 1561
- 1562 124. (original) The use of a method as described in claim 1 for a military wireless
1563 electromagnetic communications network for battlefield operations.

- 1564
- 1565 125. (currently amended) The use of an apparatus as described in claim 50[101]for a
1566 military wireless electromagnetic communications network for battlefield operations.
- 1567
- 1568 126. (original) The use of a method as described in claim 1 for a military wireless
1569 electromagnetic communications network for Back Edge of Battle Area (BEBA)
1570 operations.
- 1571
- 1572 127. (original) The use of an apparatus as described in claim 50[101]for a military
1573 wireless electromagnetic communications network for Back Edge of Battle Area (BEBA)
1574 operations..
- 1575
- 1576 128. (original) The use of a method as described in claim 1 for a wireless electromagnetic
1577 communications network for intruder detection operations.
- 1578
- 1579 129. (original) The use of an apparatus as described in claim 50[101]for a wireless
1580 electromagnetic communications network for intruder detection operations.
- 1581
- 1582 130. (original) The use of a method as described in claim 1 for a wireless electromagnetic
1583 communications network for logistical intercommunications.
- 1584
- 1585 131. (original) The use of an apparatus as described in claim 50[101]for a wireless
1586 electromagnetic communications network for logistical intercommunications.
- 1587
- 1588 132. (original) The use of a method as described in claim 1 in a wireless electromagnetic
1589 communications network for self-filtering spoofing signals.
- 1590
- 1591 133. (original) The use of an apparatus as described in claim 50[101]for a wireless
1592 electromagnetic communications network for self-filtering spoofing signals.
- 1593

- 1594 134. (original) The use of a method as described in claim 1 in a wireless
1595 electromagnetic communications network for airborne relay over the horizon.
- 1596
- 1597 135. (original) The use of an apparatus as described in claim 50[101]for a wireless
1598 electromagnetic communications network for airborne relay over the horizon.
- 1599
- 1600 136. (original) The use of a method as described in claim 1 in a wireless electromagnetic
1601 communications network for traffic control.
- 1602
- 1603 137. (currently amended) The use of a method as in claim 166[1], further comprising
1604 the use thereof for air traffic control.
- 1605
- 1606 138. (currently amended) The use of a method as in claim 166[1], further comprising
1607 the use thereof for ground traffic control.
- 1608
- 1609 139. (currently amended) The use of a method as in claim 166[1], further comprising
1610 the use thereof for a mixture of ground and air traffic control.
- 1611
- 1612 140. (original) The use of an apparatus as described in claim 50[101]for a wireless
1613 electromagnetic communications network for traffic control.
- 1614
- 1615 141. (currently amended) The use of an apparatus as in claim 170[101], further
1616 comprising the use thereof for air traffic control
- 1617
- 1618 142. (currently amended) The use of an apparatus as in claim 170[101], further
1619 comprising the use thereof for ground traffic control.
- 1620
- 1621 143. (currently amended) The use of an apparatus as in claim 170[101], further
1622 comprising the use thereof for a mixture of ground and air traffic control.
- 1623

- 1624 144. (original) The use of a method as in claim 1 in a wireless electromagnetic
1625 communications network for emergency services.
- 1626
- 1627 145. (original) The use of an apparatus as in claim 50[101]in a wireless electromagnetic
1628 communications network for emergency services.
- 1629
- 1630 146. (original) The use of a method as in claim 1 in a wireless electromagnetic
1631 communications network for shared emergency communications without interference.
- 1632
- 1633 147. (currently amended) The use of an apparatus as in claim 50[101]in a wireless
1634 electromagnetic communications network for shared emergency communications without
1635 interference.
- 1636
- 1637 148. (original) The use of a method as in claim 1 in a wireless electromagnetic
1638 communications network for positioning operations without interference.
- 1639
- 1640 149. (currently amended) The use of an apparatus as in claim 50[101]in a wireless
1641 electromagnetic communications network for positioning operations without interference.
- 1642
- 1643 150. (original) The use of a method as in claim 1 in a wireless electromagnetic
1644 communications network for high reliabilty networks requiring graceful degradation
1645 despite environmental conditions or changes..
- 1646
- 1647 151. (currently amended) The use of an apparatus as in claim 50[101]in a wireless
1648 electromagnetic communications network for high reliabilty networks requiring graceful
1649 degradation despite environmental conditions or changes..
- 1650
- 1651 152. (original) The use of a method as in claim 1 in a wireless electromagnetic
1652 communications network for a secure network requiring assurance against unauthorized
1653 intrusion.
- 1654

- 1655 153. (original) The use of a method as in claim 1 in a wireless electromagnetic
1656 communications network for a secure network requiring message end-point assurance.
- 1657
- 1658 154. (original) The use of a method as in claim 1 in a wireless electromagnetic
1659 communications network for a secure network requiring assurance against unauthorized
1660 intrusion and message end-point assurance.
- 1661
- 1662 155. (currently amended) The use of an apparatus as in claim 50[101]in a wireless
1663 electromagnetic communications network for a secure network requiring assurance
1664 against unauthorized intrusion.
- 1665
- 1666 156. (currently amended) The use of an apparatus as in claim 50[101]in a wireless
1667 electromagnetic communications network for a secure network requiring message end-
1668 point assurance.
- 1669
- 1670 157. (currently amended) The use of an apparatus as in claim 50[101]in a wireless
1671 electromagnetic communications network for a secure network requiring assurance
1672 against unauthorized intrusion and message end-point assurance.
- 1673
- 1674
- 1675 158. (original) The use of a method as in claim 1 in a cellular mobile radio service.
- 1676
- 1677 159. (currently amended) The use of an apparatus as in claim 50[101]in a cellular
1678 mobile radio service.
- 1679
- 1680 160. (original) The use of a method as in claim 1 in a personal communication service.
- 1681
- 1682 161. (currently amended) The use of an apparatus as in claim 50[101]in a personal
1683 communication service.
- 1684
- 1685 162. (original) The use of a method as in claim 1 in a private mobile radio service.

- 1686
- 1687 163. (currently amended) The use of an apparatus as in claim 50[101]in a private
1688 mobile radio service.
- 1689
- 1690 164. (original) The use of a method as in claim 1 in a wireless LAN.
- 1691
- 1692 165. (currently amended) The use of an apparatus as in claim 50[101]in a wireless LAN.
- 1693
- 1694 166. (original) The use of a method as in claim 1 in a fixed wireless access service.
- 1695
- 1696 167. (currently amended) The use of an apparatus as in claim 50[101]in a fixed wireless
1697 access service.
- 1698
- 1699 168. (original) The use of a method as in claim 1 in a broadband wireless access service.
- 1700
- 1701 169. (currently amended) The use of an apparatus as in claim 50[101]in a broadband
1702 wireless access service.
- 1703
- 1704 170. (original) The use of a method as in claim 1 in a municipal area network.
- 1705
- 1706 171. (currently amended) The use of an apparatus as in claim 50[101]in a municipal area
1707 network.
- 1708
- 1709 172. (original) The use of a method as in claim 1 in a wide area network.
- 1710
- 1711 173. (currently amended) The use of an apparatus as in claim 50[101]in a wide area
1712 network.
- 1713
- 1714 174. (original) The use of a method as in claim 1 in wireless backhaul.
- 1715

- 1716 175. (currently amended) The use of an apparatus as in claim 50[101]in wireless
1717 backhaul.
- 1718
- 1719 176. (original) The use of a method as in claim 1 in wireless backhaul.
- 1720
- 1721 177. (currently amended) The use of an apparatus as in claim 50[101]in wireless
1722 backhaul.
- 1723
- 1724 178. (original) The use of a method as in claim 1 in wireless SONET.
- 1725
- 1726 179. (currently amended) The use of an apparatus as in claim 50[101]in wireless SONET.
- 1727
- 1728 180-181. (Cancelled)
- 1729
- 1730 182. (original) The use of a method as in claim 1 in wireless Telematics.
- 1731
- 1732 183. (currently amended) The use of an apparatus as in claim 50[101]in wireless
1733 Telematics.
- 1734